

CLAIMS

What is claimed is:

- 1 1. A machine-readable medium having stored thereon instructions, which
2 when executed by one or more processors, cause said processors to perform the
3 following:
- 4 a) create a string that models a trace, said string having a collection of
5 lumped elements, at least one of said lumped elements having a cross
6 capacitor;
7 b) reduce said string to a pi model, said pi model having a cross
8 capacitor; and
9 c) simulate the application of an applied noise voltage to said cross
10 capacitor.
- 1 2. The machine-readable medium of claim 1 wherein said reduce said string to
2 a pi model further comprises reducing the number of capacitors and resistors in
3 said string.
- 1 3. The machine-readable medium of claim 2 wherein said reducing said string
2 to a pi model further comprises reducing six capacitors and two resistors in said
3 string to four capacitors and one resistor.

1 4. The machine-readable medium of claim 3 wherein said reduction of six
2 resistors and four capacitors is performed according to an Elmore influenced
3 reduction method.

1 5. The machine-readable medium of claim 3 wherein said reduction of resistors
2 and capacitors is performed according to an O'Brien/Savarino influenced
3 reduction method.

1 6. The machine-readable medium of claim 1 wherein said string further
2 comprises a number of paths, said reduction of said string to a pi model
3 performed for one of said paths.

1 7. The machine-readable medium of claim 1 wherein said application of a noise
2 voltage further comprises applying a voltage ramp as said applied noise
3 voltage.

1 8. The machine-readable medium of claim 7 wherein the ramp time of said
2 voltage ramp is multiplied by a factor to correct for the characteristics of an
3 actual driving transistor.

1 9. The machine-readable medium of claim 1 wherein said instructions are such
2 that said reduce said string to a pi model may be performed on a first apparatus

3 and said create a string that models a trace may be performed on a second
4 apparatus.

1 10. The machine-readable medium of claim 1 further comprising instructions
2 that add a resistor to said pi model as a linear source model.

1 11. The machine-readable medium of claim 1 further comprising instructions
2 that allow a user to observe a noise voltage waveform on a victim node of said
3 pi model.

1 12. The machine-readable medium of claim 1 further comprising instructions
2 that calculate the peak noise voltage on a victim node of said pi model caused
3 by said applied noise voltage.

1 13. The machine-readable medium of claim 1 further comprising instructions
2 that apply a second applied noise voltage to a second cross capacitor of said pi
3 model.

1 14. The machine-readable medium of claim 13 wherein said applied noise
2 voltage and said second applied noise voltage are voltage ramps having their
3 end or ramp times in phase.

1 15. The machine-readable medium of claim 13 further comprising instructions
2 that calculate the peak noise caused by said applied noise voltage and said
3 second applied noise voltage at a source point of said pi model.

1 16. The machine-readable medium of claim 13 further comprising instructions
2 that calculate the peak noise caused by said applied noise voltage and said
3 second applied noise voltage at a load point of said pi model.

1 17. The machine-readable medium of claim 1 wherein said reduce said string to
2 a pi model further comprises reducing said string to a reduced string then
3 reducing said reduced string to a simple string having resistors in series and
4 capacitors in parallel, said capacitors separated by one of said resistances, then
5 reducing said simple string to a pi-model.

1 18. A machine-readable medium having stored thereon instructions, which
2 when executed by one or more processors, cause said set of processors to
3 perform the following:

4 a) create a string that models a trace, said string having a collection of
5 lumped elements, at least one of said lumped elements having a
6 plurality of cross capacitors on a node, each of said cross capacitors
7 corresponding to a different proximate trace;

- 8 b) add said plurality of cross capacitors together to form a reduced
9 string;
10 c) reduce said reduced string to a pi model, said pi model having a
11 cross capacitor; and
12 d) simulate the application of an applied noise voltage to said cross
13 capacitor.

1 19. The machine-readable medium of claim 18 wherein said reduce said
2 reduced string to a pi model further comprises reducing the number of
3 capacitors and resistors in said reduced string.

1 20. The machine-readable medium of claim 19 wherein said reduce said
2 reduced string to a pi model further comprises reducing six capacitors and two
3 resistors in said string to four capacitors and one resistor.

1 21. The machine-readable medium of claim 20 wherein said reduction of six
2 resistors and four capacitors is performed according to an Elmore influenced
3 reduction method.

1 22. The machine-readable medium of claim 20 wherein said reduction of
2 resistors and capacitors is performed according to an O'Brien/Savarino
3 influenced reduction method.

1 23. The machine-readable medium of claim 18 wherein said string further
2 comprises a number of paths, said reduction of said string to a pi model
3 performed for one of said paths.

1 24. The machine-readable medium of claim 18 wherein said apply a noise
2 voltage further comprises applying a voltage ramp as said applied noise
3 voltage.

1 25. The machine-readable medium of claim 24 wherein said voltage ramp
2 further comprises an equivalent ramp time that approximates the worst case
3 noise caused by said plurality of proximate traces.

1 26. The machine-readable medium of claim 18 wherein said instructions are
2 such that said reduce said reduced string to a pi model may be performed on a
3 first apparatus and said create a string that models a trace may be performed on
4 a second apparatus.

1 27. The machine-readable medium of claim 18 wherein said reduce said
2 reduced string to a pi model further comprises reducing said reduced string to
3 a simple string then reducing said simple string to a pi-model.

1 28. An apparatus, comprising:

2 a computer having a design tool configured to:

3 a) recognize a string that models a trace, said string having a

4 collection of lumped elements, at least one of said lumped

5 elements having a cross capacitor;

6 b) reduce said string to a pi model, said pi model having a cross

7 capacitor; and

8 c) simulate the application of an applied noise voltage to said

9 cross capacitor.

1 29. A machine-readable medium having stored thereon instructions which

2 when executed by one or more processors cause said processors to perform

3 the following:

4 calculate a plurality of discrete samples from an overall applied

5 noise voltage waveform and simulate the application of each of said

6 plurality of discrete samples to a cross capacitor, said cross capacitor

7 associated with a pi model, said pi model reduced from a string.

1 30. The machine-readable medium of claim 29 further comprising instructions

2 that assemble a plurality of observed noise voltages from the simulation of

3 the application of each of said discrete samples.

1 31. The machine-readable medium of claim 30 further comprising instructions
2 that display an overall observed noise voltage waveform produced from
3 said plurality of observed noise voltages.

1 32. The machine-readable medium of claim 29 wherein said overall applied
2 noise voltage waveform is a ramp.

1 33. A method, comprising:

- 2 a) create a string that models a trace, said string having a collection of
3 lumped elements, at least one of said lumped elements having a cross
4 capacitor;
5 b) reduce said string to a pi model, said pi model having a cross
6 capacitor; and
7 c) simulate the application of an applied noise voltage to said cross
8 capacitor.

1 34. The method of claim 33 wherein said reduce said string to a pi model
2 further comprises reducing the number of capacitors and resistors in said
3 string.

1 35. The method of claim 34 wherein said reducing said string to a pi model
2 further comprises reducing six capacitors and two resistors in said string to four
3 capacitors and one resistor.

1 36. The method of claim 35 wherein said reduction of six resistors and four
2 capacitors is performed according to an Elmore influenced reduction method.

1 37. The method of claim 35 wherein said reduction of resistors and capacitors is
2 performed according to an O'Brien/Savarino influenced reduction method.

1 38 The method of claim 33 wherein said string further comprises a number
2 of paths, said reduction of said string to a pi model performed for one of
3 said paths.

1 39. The method of claim 33 wherein said application of a noise voltage further
2 comprises applying a voltage ramp as said applied noise voltage.

1 40. The method of claim 39 wherein the ramp time of said voltage ramp is
2 multiplied by a factor to correct for the characteristics of an actual driving
3 transistor.

1 41 The method of claim 33 wherein said reduce said string to a pi model is
2 performed on a first apparatus and said create a string that models a trace is
3 performed on a second apparatus.

1 42. The method of claim 33 further comprising add a resistor to said pi model
2 as a linear source model.

1 43 The method of claim 33 further comprising observe noise voltage on a
2 victim node of said pi model.

1 44. The method of claim 33 further comprising calculate the peak noise voltage
2 on a victim node of said pi model caused by said applied noise voltage.

1 45. The method of claim 33 further comprising apply a second applied noise
2 voltage to a second cross capacitor of said pi model

1 46. The method of claim 45 wherein said applied noise voltage and said second
2 applied noise voltage are voltage ramps having their end or ramp times in
3 phase.

1 47. The method of claim 45 further comprising calculate the peak noise caused
2 by said applied noise voltage and said second applied noise voltage at a source
3 point of said pi model.

1 48. The method of claim 45 further comprising calculate the peak noise caused
2 by said applied noise voltage and said second applied noise voltage at a load
3 point of said pi model.

1 49. The method of claim 33 wherein said reduce said string to a pi model
2 further comprises reducing said string to a reduced string then reducing said
3 reduced string to a simple string having resistors and capacitors in parallel, said
4 capacitors separated by one of said resistors then reducing said simple string to
5 a pi-model.

1 50. A method, comprising:

- 2 a) create a string that models a trace, said string having a collection of
3 lumped elements, at least one of said lumped elements having a
4 plurality of cross capacitors on a node, each of said cross capacitors
5 corresponding to a different proximate trace;
6 b) add said plurality of cross capacitors together to form a reduced string;
7 c) reduce said reduced string to a pi model, said pi model having a cross
8 capacitor; and

9 d) simulate the application of an applied noise voltage to said cross
10 capacitor.

1 51. The method of claim 50 wherein said reduce said reduced string to a pi
2 model further comprises reducing the number of capacitors and resistors in
3 said reduced string.

1 52. The method of claim 51 wherein said reduce said reduced string to a pi
2 model further comprises reducing six capacitors and two resistors in said string
3 to four capacitors and one resistor.

1 53. The method of claim 52 wherein said reduction of six resistors and four
2 capacitors is performed according to an Elmore influenced reduction method.

1 54. The method of claim 52 wherein said reduction of resistors and capacitors is
2 performed according to an O'Brien/Savarino influenced reduction method.

1 55. The machine-readable medium of claim 50 wherein said string further
2 comprises a number of paths, said reduction of said string to a pi model
3 performed for one of said paths.

1 56. The method of claim 50 wherein said apply a noise voltage further
2 comprises applying a voltage ramp as said applied noise voltage.

1 57. The method of claim 56 wherein said voltage ramp further comprises an
2 equivalent ramp time that approximates the worst case noise caused by said
3 plurality of proximate traces.

1 58. The method of claim 50 wherein said reduce said reduced string to a pi
2 model is performed on a first apparatus and said create a string that models a
3 trace is performed on a second apparatus.

1 59. The method of claim 50 wherein said reduce said reduced string to a pi
2 model further comprises reducing said reduced string to a simple string then
3 reducing said simple string to a pi-model.

1 60. A method, comprising:
2 calculate a plurality of discrete samples from an overall applied
3 noise voltage waveform and simulate the application of each of said
4 plurality of discrete samples to a cross capacitor, said cross capacitor
5 associated with a pi model, said pi model reduced from a string.

1 61. The method of claim 60 further comprising assemble a plurality of
2 observed noise voltages from the simulation of the application of each of said
3 discrete samples.

1 62. The method of claim 61 further comprising display an overall observed
2 noise voltage waveform produced from said plurality of observed noise
3 voltages.

1 63. The method of claim 60 wherein said overall applied noise voltage
2 waveform is a ramp